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PRODUCT PLAN PREPARATION DEVICE  
[SEIHIN PURAN SAKUSEI SOUCHI]

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[Scope of the Patent Claims]

[Claim 1] A product plan preparation device which is characterized by a product plan preparation device, which prepares a product plan by adjusting the sales side conditions and the production side conditions for a plurality of products that are produced by sequentially passing through processes according to various types of products among the production line which is comprised of sequential handling processes, being equipped with a target product plan establishment means that establishes a target product plan such as satisfying the respective abovementioned sales side conditions for a plurality of products that are produced in the period, a target manufacturing plan preparation means that prepares a neck process target manufacturing plan with a production initialization day of each target product which is established by the abovementioned target product plan establishment means moved ahead until the starting point of neck production with the lowest production capacity among the processes according to the plurality of the said products of the abovementioned production line, a product plan preparation means that prepares in plurality the neck process production plan candidates with the production initialization date of the product plan which is prepared as satisfying the respective abovementioned production side conditions for a plurality of products that are produced within the abovementioned period, moved ahead until the starting point of the abovementioned neck process, and a product plan selection means that selects 1 of candidate from among the abovementioned neck process manufacturing plan candidates based on the target satisfaction rate index which indicates the deviation of a neck process target production plan that is prepared by the abovementioned target production plan

preparation means and each candidate of the neck process production plan which is prepared by the abovementioned production plan preparation means and/or on the productivity index which indicates the productivity of each candidate of the abovementioned neck production plans, and a product plan determination means that determines each product plan of a plurality of products that are prepared in the abovementioned period based on the abovementioned 1 candidate of the neck process production plan that is selected by the abovementioned production plan selection means.

[Claim 2] A product plan preparation device as claimed in Claim 1 wherein the abovementioned target product plan establishment means with the target production plan of a plurality of products that are produced in the abovementioned period are standardized by the said period for each product type.

[Claim 3] A product plan preparation device as claimed in Claim 1 or 2 wherein the abovementioned product plan selection means selects 1 candidate from among the abovementioned neck production plans based on the weighted total of the abovementioned target satisfaction index and the abovementioned productivity index.

[Claim 4] A product plan preparation device as claimed in Claim 3 wherein the abovementioned weighting is modified when 1 candidate is selected from among the abovementioned neck process production plan candidates by the abovementioned production plan selection means.

[Detailed Explanation of the Invention]

[0001]

[Industrial Field of Utilization] The present invention relates to a product plan preparation device, and especially pertains to a device which prepares a product plan

by adjusting the sale side conditions and the production side conditions for a plurality of products that are produced by passing through processes according to various types of products within the production plan that are comprised of sequential handling processes.

[0002]

[Prior Art] Previously, establishment of a product plan, which should predict adjustments of the sale side conditions (i.e., delivery date of a product) and production side conditions (i.e., production capacity), was attempted for corporate activity that extended from the production of products to the sale (Japanese Kokai Patent No. H04145573). Figure 9 is a type diagram that shows a schematic system for one example of a prior product plan preparation device A0 like this. As shown in Figure 9, a production position (product plan) of each type of suitable product and each period was previously established, this was entered into the database 1 of a computer by a prior product plan preparation device A0, and employed. The sale side inputs order data from a terminal 2. The input order data is entered for the production position of a period that is established on the data base by means of data processing section 3 and communication circuit 4, and by means of data base management device 5. This entry result is displayed on the terminal 2 via the abovementioned input and a reverse path, and the sale side can obtain shipping response and the like from this. Further, when the production position is filled, the sale side enters order data for the production position of the next period. On the other hand, the production side enters production data for the production position from terminal 6 via data processing section 7 and communication circuit 4, and, further, via data base management device 5. This entry result is also displayed on terminal 6.

Therefore, the original management of the order data and production data is created on database 1. Thus, adjustment can be performed on both sides.

[0003]

[Problems to be Solved by the Invention] A long period is required for the adjustment itself of the sale side and production side since there is manual operation intervening with the production position (product plan) by a prior product plan preparation device as abovementioned. Further, the performance of objective optimal adjustments is complicated. The present invention has the objective of offering a product plan preparation device that that adjusts and obtains such as the sale side conditions and production side conditions being optimal although in a comparatively short period by improving the product plan preparation device in order to solve the problems of prior art.

[0004]

[Means for Solving the Problems] The present invention, in order to realize the abovementioned objective, is constructed as a product plan preparation device which is characterized by a product plan preparation device, which prepares a product plan by adjusting the sales side conditions and the production side conditions for a plurality of products that are produced by sequentially passing through processes according to various types of products among a production line which is comprised of sequential handling processes, being equipped with a target product plan establishment means that establishes a target product plan such as satisfying the respective abovementioned sales side conditions for a plurality of products that are produced in the period,

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a target manufacturing plan preparation means that prepares a neck process target manufacturing plan with a production initialization day of each target product which is determined by the abovementioned target product plan establishment means moved ahead until the starting point of neck production with the lowest production capacity among the processes according to the plurality of the said products of the abovementioned production line, a product plan preparation means that prepares in plurality the neck process production plan candidates with the production initialization date of the product plan which is prepared as satisfying the respective abovementioned production side conditions for a plurality of products that are produced within the abovementioned period, moved ahead until the starting point of the abovementioned neck process, and a product plan selection means that selects 1 of the candidates from among the abovementioned neck process manufacturing plan candidates based on the target satisfaction rate index which indicates the deviation of a neck process target production plan that is prepared by the abovementioned target production plan preparation means and each candidate of the neck process production plan which is prepared by the abovementioned production plan preparation means and/or on the productivity index which indicates the productivity of each candidate of the abovementioned neck production plans, and a product plan determination means that determines each product plan of a plurality of products that are prepared in the abovementioned period based on the abovementioned 1 candidate of the neck process production plan that is selected by the abovementioned production plan selection means. Further, a product plan preparation device wherein the abovementioned target product plan establishment means with the target production plan of a plurality of products that are produced in the abovementioned period are standardized by the said

period for each product type. Further, a product plan preparation device wherein the abovementioned product plan selection means selects 1 candidate from among the abovementioned neck production plans based on the weighted total of the abovementioned target satisfaction index and the abovementioned productivity index. Further, a product plan preparation device wherein the abovementioned weighting is modified when 1 candidate is selected from among the abovementioned neck process production plan candidates by the abovementioned production plan selection means.

[0005]

[Utilization] According to the present invention, a target product plan is established by a target product plan determination means as satisfying the respective abovementioned sales side conditions for a plurality of products that are produced in the period when a product plan is prepared by adjusting the sales side conditions and the production side conditions for a plurality of products that are produced by sequentially passing through processes according to a variety of products within a production line that is comprised of sequential handling processes. A neck process target product plan is prepared by a target manufacturing plan preparation means, which moves up the manufacturing initialization date of each target product plan that is established by the abovementioned target product plan establishment means to a starting point of a neck process with the lowest production capacity among the processes according to the various types of the said products of the abovementioned production line. 1 candidate is selected by the manufacturing plan selection means from among the abovementioned neck process manufacturing plans based on the target satisfaction index which indicates the deviation of the neck process target manufacturing plan that is prepared the



abovementioned target manufacturing plan preparation means and each candidate of the neck process manufacturing plan that is prepared by the abovementioned manufacturing plan preparation means and/or the productivity index which indicates the productivity of each candidate of the abovementioned neck process manufacturing plan. Each product plan of a plurality of products that are produced in the abovementioned period is determined by the product plan determination means based on the abovementioned 1 candidate of a neck process manufacturing plan that is selected from by the abovementioned manufacturing plan selection means. Further, a product plan can be prepared such as being optimum although the adjustment of the sales side conditions and the production side conditions is in a comparatively short period. Further, the abovementioned target product plan determination means can predict the standardization also of the product plan that is finally obtained when a target product of a plurality of products that are produced in the abovementioned period are standardized in the said period for each product. Further, the optimization of the product plan can be predicted by selecting 1 candidate from among the candidates of the abovementioned neck process manufacturing plans based on the weighted total of the abovementioned target satisfaction index and the abovementioned productivity index by the abovementioned manufacturing plan selection means. Further, the optimization of the product plan can be performed in a short period by modifying the abovementioned weighting when 1 candidate is selected from among the candidates of the abovementioned neck process manufacturing plan by the abovementioned manufacturing plan selection means.

[0006]

[Example] Examples that embody the present invention are next explained by referring to the following attached figures, and are offered for understanding of the present invention. Further, the following examples are examples that embody the present invention without having characteristics that limit the technical scope of the present invention. Here, Figure 1 is a block diagram that shows a schematic structure of a product plan preparation device A1 pertaining to an example of the present invention; Figure 2 is an explanatory diagram that shows the operation flow of a product plan preparation device A1; Figure 3 is an explanatory diagram that shows a standard plan example; Figure 4 is an explanatory diagram that shows a neck process standard manufacturing plan example; Figure 5 is an explanatory diagram that shows a product plan example; Figure 6 is an explanatory diagram that shows a product plan example; Figure 7 is an explanatory chart of a neck process; and Figure 8 is an explanatory diagram that show modification of the cumulative manufacturing amount of products A, B for a neck process standard manufacturing plan. As shown in Figure 1, the product plan preparation device A1 pertaining to the present example, when a product plan is prepared by adjusting the sales side conditions (i.e., delivery date of a product) and the production side conditions (i.e., production capacity) for a plurality of products that are produced by sequentially passing through processes according to the various types of products in the product line that is comprised of sequential handling processes, is equipped with a target product plan establishment section 1 (corresponding to a target product plan establishment means) that establishes the target product plan such as satisfying the

respective sales side conditions for a plurality of products that are produced in the period, a target manufacturing plan preparation section 2 (corresponding to a target manufacturing plan preparation means) that prepares a neck process target manufacturing plan with the manufacturing initialization date of each target product plan that is established by the target product plan establishment section 1 moved up to the starting point of a neck process with the lowest production capacity among the processes according to the various types of the said products of the production line, a manufacturing plan preparation section 3 (corresponding to manufacturing plan preparation means) that prepares in plurality the candidates of the neck process manufacturing plan with the manufacturing initialization date of the product plan that is prepared such as satisfying the respective production side conditions for a plurality of products that are produced in the period moved up to the starting point of the neck process,

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a manufacturing plan selection section 4 (corresponding to a manufacturing plan selection means) that selects 1 candidate from among the candidates of the neck process manufacturing plans based on the target satisfaction index which indicates the deviation of the neck process target manufacturing plan that is prepared by the target plan preparation section 2 and each candidate of the neck process manufacturing plan that is prepared by a manufacturing plan preparation section 3 and/or the productivity index which indicates the productivity of each candidate of the neck process manufacturing plan, and a product plan determination section 5 (corresponding to a product plan determination means) that determines each product plan of a plurality of products that are

produced in the period based on 1 candidate of the neck process manufacturing plan that is selected by the manufacturing plan selection section 4.

[0007] Below, the operation of this device A1 is briefly explained by referring to Figure 2 ~ Figure 6. Here, a product plan being prepared for a 1 month section for 2 types of products A, B is taken as an example for explanation. First, the total predicted sales amount of each product type during 1 month is input as shown in Figure 2 (S1). The product A is 30 t/month and product B is 60 t/month. Next, each product type A, B is standardized for the period (S2). This is called the standard product plan, and shows the abovementioned sales side conditions (corresponding to target product plan).

Product A:  $30 \text{ t}/30 \text{ days} = 1 \text{ t/day}$

Product B:  $60 \text{ t}/30 \text{ days} = 2 \text{ t/day}$

An example of the abovementioned standard product plan is shown in Figure 3. Next, the standard product plan is the neck process standard manufacturing plan by moving up to the starting point of the neck process of its production line (corresponding to a neck process target manufacturing plan). Here, the process with the least production capacity for the manufacturing line is the neck process. For example, process 2 which is shown in Figure 7 corresponds to this neck process. The production capacity of this neck process is 2 t/day for products A and B together. At this time, the block number that is the processed amount per 1 day of products A, B becomes  $30 \text{ t}/2\text{t} = 15$  units, product B:  $60 \text{ t}/2\text{t} = 30$  units. The abovementioned neck process standard manufacturing plans have these blocks moved up to the starting point of the neck process the line (S3). An example of that is shown in Figure 4. In the figure, the process period and the like generally differ by the pass through process, the pass through process number and the process the product

A, B plans by the various types of products fluctuates for the products A, B, and the manufacturing lead time from the neck process differs. Here, the manufacturing lead time is the time (number of days) that is required from manufacturing initialization until completion. In this example, the manufacturing time is long for product B is compared to product A, therefore the initialization of the manufacturing for product B must be earlier than product A in order to ship on the same day. Further, the product A, B plans overlap without considering the production side conditions (i.e., the production capacity is a maximum of 2 t/day) in Figure 4.

[0008] Next, the candidates of the neck process manufacturing plan are prepared in plurality on a line with each block of product A, B. Here, the proportions are considered such as satisfying the abovementioned production side conditions. That is, first, the proportions as shown in Figure 5 (A) are considered as initial values. The next candidate is prepared by rearranging the evaluation coefficient E as the proportions are next shown, to a minimum. The evaluation coefficient E can be shown by the weighted sum of the standardization index which is the deviation of the neck process standard manufacturing plan and each candidate of the neck process manufacturing plan and the step substitution frequency that is the target which indicates the productivity of each candidate of the neck process manufacturing plan, and can be represented by the following equation.

$$E = [\text{small omega}]_1 \times \text{standardization index} + [\text{small omega}]_2 \times \text{step substitution frequency}$$

Here,  $[\text{small omega}]_1$ ,  $[\text{small omega}]_2$  show the weighted relationship respectively given for products A, B. Further, the standardization index can be

determined by comparing the respective cumulative manufacturing amounts of products A, B for the neck process standard manufacturing plan and the respective cumulative manufacturing amount of products A, B for the neck process manufacturing plan as shown in Figure 8. The standardization index corresponds to the target satisfaction index and the step substitution frequency corresponds to the productivity index. Thus, the candidates of the sequential neck process manufacturing plan are prepared using a conventional means like a simulated annealing method such as this evaluation coefficient  $E$  becoming the minimum (S4). Preparation examples of each candidate of the neck process manufacturing plan are shown in Figures 5 (B), (C). Further, the initial values are shown, along with modifications of the standardization index and step substitution frequency. Further, a case where  $[\text{small } \omega]_1 = 0$  and  $[\text{small } \omega]_2 = 1$  are shown here. In this case, the productivity is given priority and the neck process manufacturing plan is prepared such that the step substitution frequency becomes minimal. 1 candidate is selected from among each candidate of the neck process manufacturing plan that is prepared like this (S5) (also, the optimization of the neck process manufacturing plan can be performed in Steps S4, S5). Figure 5 (c) shows an example that is finally selected. In the figure, product A is produced after product B is produced as a priority, this has a result such that the step substitution frequency becomes minimal by prioritizing the productivity. Next, the neck process manufacturing plan that is finally selected is used, and is developed by simulation and the like for the schedule of a downstream process after that process, and the respective product plans for products A, B are prepared (S6). An example of a prepared product plan is shown in Figure 6. Thus, the prepared product plan is complete when there is a product plan that can satisfy by objectively evaluating

whether or not there is a product plan that can satisfy by being evaluated by a human. Modification of weighted [small omega]1, [small omega]2 of the abovementioned evaluation coefficient E is performed for cases when the result does not satisfy, and Steps S4 ~ S7 are repeated until there is a product plan that can satisfy [this condition]. Further, the neck process manufacturing plan that is prepared in the correct number Step S4 is corrected, and Steps S6 ~ S7 are repeated until there is a satisfactory plan (S7). For example, the product plan of product A is completed in the latter half of the month in the abovementioned example. This is performed by being handled as follows when unsatisfactory.

[0009] 1. The weighted [small omega]2 is small for the step substitution frequency by the steps that are performed for optimization of Steps S4, S5, the optimizing calculation is performed, and Step S6 is executed.

2. The neck process manufacturing plan that is prepared by Steps S4, S5 is directly altered, and the product plan is checked by Step S6.

The abovementioned Steps S1, S2 are executed by the target product plan establishment section 1 in Figure 1,

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Step S3 is executed by the target manufacturing plan preparation section 2, Steps S4, S7 are executed by the manufacturing plan preparation section 3, Step S5 is executed by the manufacturing plan selection section 4 and Step S6 is executed by the product plan determination section 5. As above, a product plan can be prepared with things like the production plan productivity, and the product plan standardization being optimized with good efficiency in a short period according to the abovementioned example. The result is

that a product plan preparation device can be obtained which is obtained by adjusting the sales side conditions and the production side conditions even in a comparatively short period. Further, a candidate of a neck process manufacturing plan can be sequentially prepared by Step S4 in the abovementioned example, but all candidates can also be prepared simultaneously in actual applications. In that case, the calculated period is contracted according to the conditions due to not being repeatedly calculated. Further, only the standardization index and step substitution frequency are considered for the evaluation coefficient E in the abovementioned example, but the productivity deficit amount (amount that is produced by exceeding the limits that were determined from the relationship of the number of production days) can also be considered for this when actually applied. In that case, the application can also be for productivity without a margin for shipping. Further, a method as follows can be considered when plan evaluation is performed by a human as a final evaluation.

1. The direct product plan is corrected when a neck process optimum calculation is only slightly corrected (for example, when desiring to advance a schedule by only 1 day).
2. Recalculation can be performed by modifying the weighting when the manufacturing plan that is prepared by the established weighting does not agree with plans that were conceptualized by a human. This weighted adjustment is good when there is 1 time weighted adjustment with agreement to policy when management policy of a facility with the production line is fixed for this weighting adjustment (e.g., if there is a productivity precedent or a standardization precedent) established.



[0010]

[Effect of the Invention]      A product plan preparation device pertaining to the present invention can prepare a product plan such as the productivity of the production line and the product plan standardization, and such being optimized with good efficiency in a short period due to being constructed as abovementioned. The effect is that a product plan preparation device can be obtained that is realized such as the sales side conditions and the production side conditions being optimized although in a short period.

[Simple Explanation of the Figures]

[Figure 1] is a block diagram that shows an abbreviated construction of a product plan preparation device A1 pertaining to an example of the present invention.

[Figure 2] is an explanatory diagram that shows the operation flow of a product plan preparation device A1.

[Figure 3] is an explanatory diagram that shows a standard plan example.

[Figure 4] is an explanatory diagram that shows a neck process standard manufacturing plan example.

[Figure 5] is an explanatory figure that shows a neck process manufacturing plan example.

[Figure 6] is an explanatory diagram that shows a product plan example.

[Figure 7] is an explanatory chart that of a neck process.

[Figure 8] is explanatory diagram that shows modifications of a cumulative manufacturing amount of products A, B for a neck process standard manufacturing plan.

[Figure 9] is a type diagram that shows an abbreviated system construction for one example of a prior product plan preparation device A0.

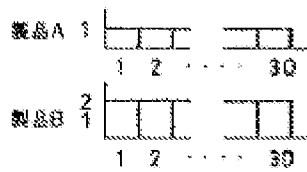
[Explanation of the Symbols]

- 1... target product plan establishment section (corresponding to a target product plan establishment means)
- 2... target manufacturing plan preparation section (corresponding to a target manufacturing plan preparation means)
- 3... manufacturing plan preparations section (corresponding to a manufacturing plan preparation means)
- 4... manufacturing plan selection section (corresponding to a manufacturing plan selection means)
- 5... product plan determination section (corresponding to a product plan determination means)

[Figure 3]  
Standard Product Plan (Target Product Plan)

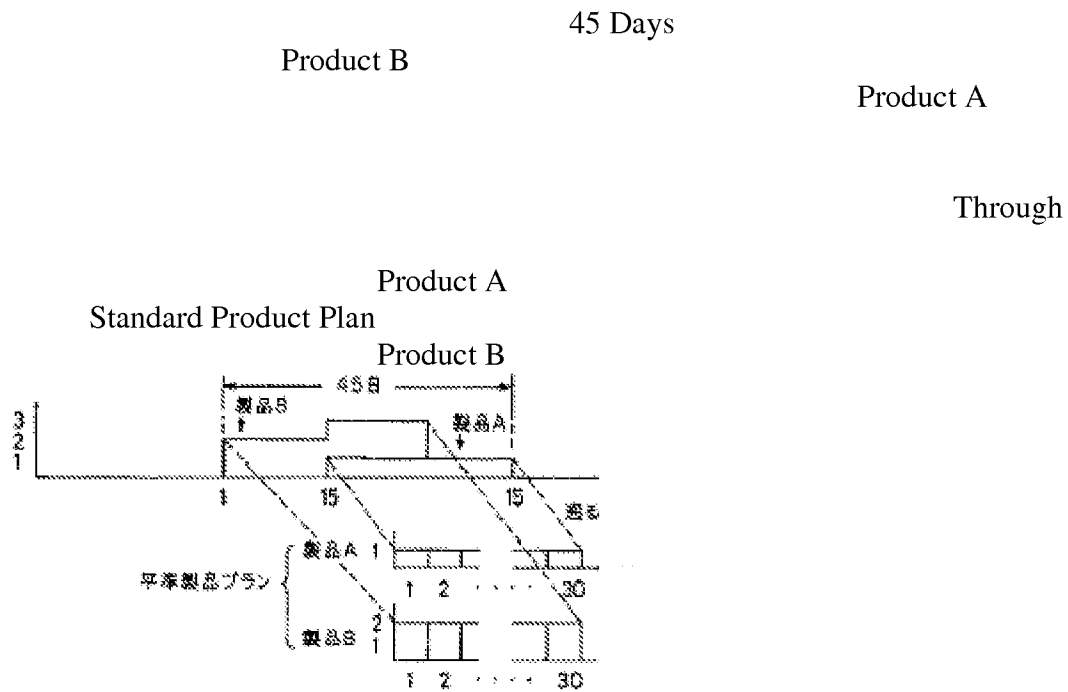
Product A

Product B



[Figure 4]

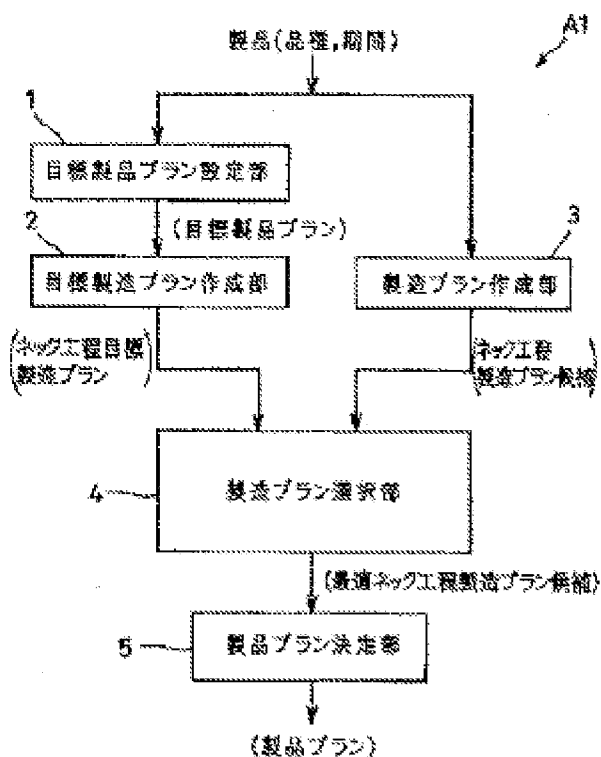
Neck Process Standard Manufacturing Plan (Neck Process Target Manufacturing Plan)



[Figure 1]

Product (Product Type, Period)

- 1 Target Product Plan Establishment Section  
(Target Product Plan)
- 2 Target Manufacturing Plan Preparation Section  
(Neck Process Target Manufacturing Plan)
- 3 Manufacturing Plan Preparation Section  
(Neck Process Manufacturing Plan Candidate)
- 4 Manufacturing Plan Selection Section  
(Optimum Neck Process Manufacturing Plan Candidate)
- 5 Product Plan Determination Section  
(Product Plan)



[Figure 2]

Target Product Plan Establishment

S1 Sales Prediction Input of Period

S2 Standardization for Each Product Type

S3 Moved Up to Neck Process

S4 Preparation of Neck Process Manufacturing Plan Candidate

S5 Selection of Neck Process Manufacturing Plan

- Weighted Correction
- (Manufacturing Plan Correction (Procedure))

S6 Development for Product Plan

S7 Product Plan OK? NO

YES

End



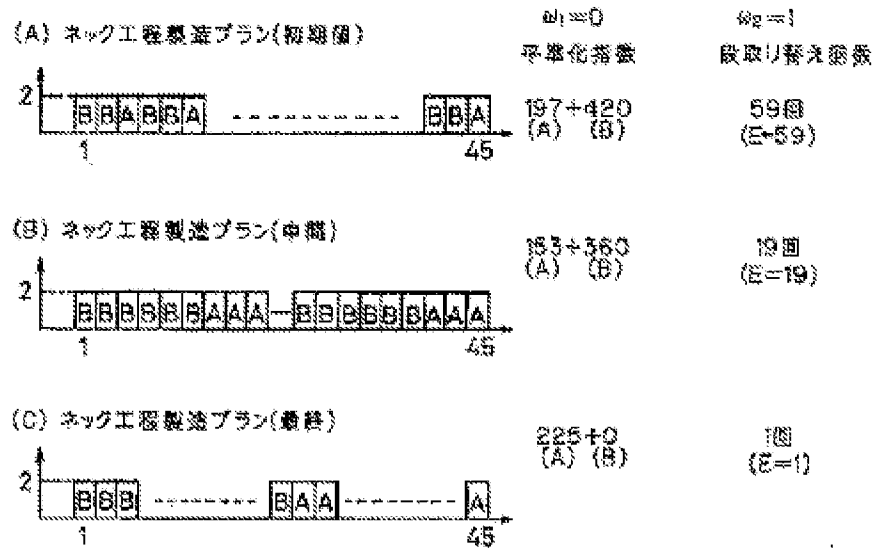
[Figure 5]

(A) Neck Process Manufacturing Plan (Initial Value)

	[omega]1 = 0	[omega]2 = 1
	Standardization	Step
	Index	Substitution
		Frequency
		times

(B) Neck Process Manufacturing Plan (Intermediate) times

(C) Neck Process Manufacturing Plan (Complete) time





[Figure 7]

Process	<Process 1>	<Process 2>	<Process 3>	<Process 4>
Production Capacity	4 t/Day	1 t/Day	3 t/Day	1 t/Day
Number of Machines	1	2	1	3
Production Capacity of Process	4 t/Day	2 t/Day	3 t/Day	3 t/Day

\*Neck Process

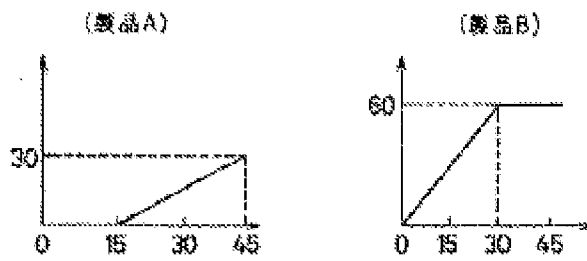
工程	〈工程1〉	〈工程2〉	〈工程3〉	〈工程4〉
生産能力	4t/日	1t/日	3t/日	1t/日
機械台数	1	2	1	3
工程の生産能力	4t/日	2t/日	3t/日	3t/日

、ネック工程

[Figure 8]

(Product A)

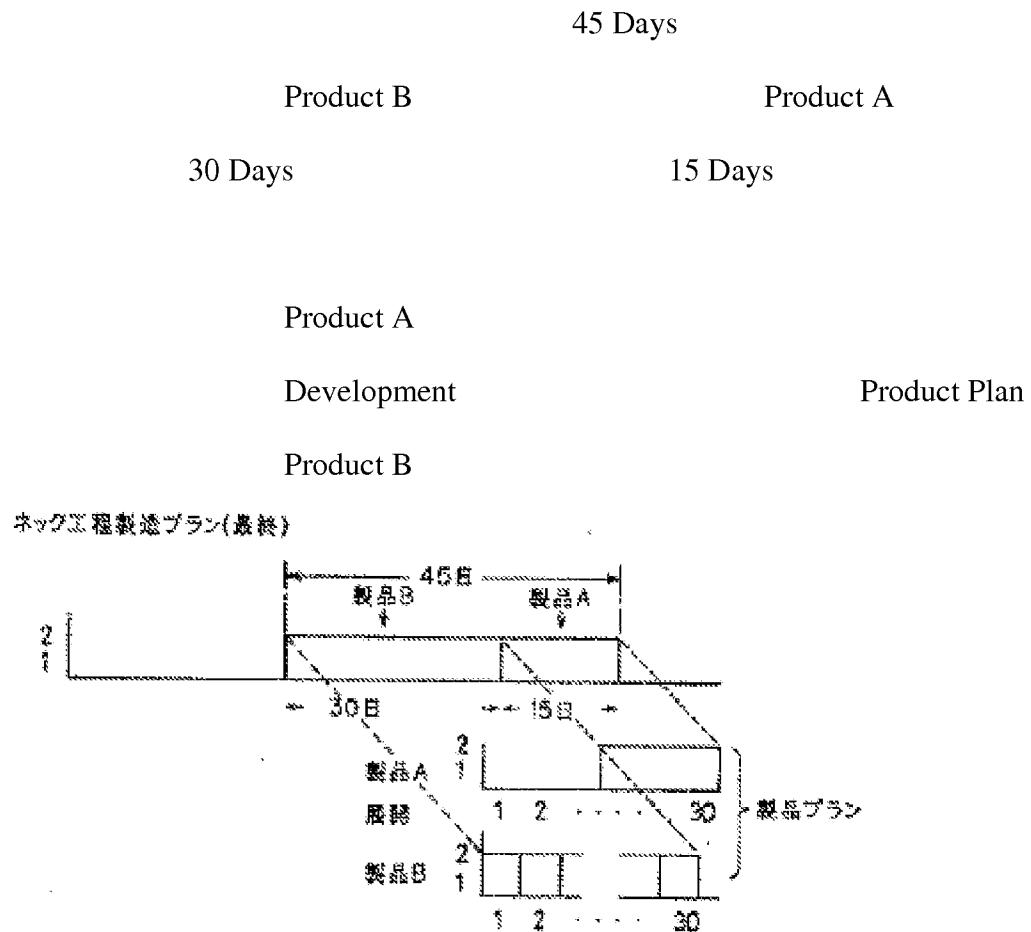
(Product B)



[Ordinate] Cumulative Manufacturing Amount

[Figure 6]

Neck Process Manufacturing Plan (Final)



[Figure 9]

